Water , Water Ever ywhere! How Does It Compare?

Purpose

To see how water characteristics can vary with location and to encourage students to see how other sites compare to theirs. To illustrate to students how scientists are beginning to explore their data and to encourage students to begin their own data analyses.

Overview

Students will be asked to examine initial student data which scientists have identified from the GLOBE data set. After reading the scientist's comments about the data, students will then be asked to find additional data from GLOBE schools to explore and analyze.

Time

One class period for the initial activity and ongoing for follow-up

Level

Intermediate and Advanced

Key Concepts

Water characteristics vary (within some limits).
Data are used to pose questions.
Data are used to answer questions.

Skills

Graphing data
Making comparisons over space and time
Analyzing data for trends and differences
Forming hypotheses
Testing hypotheses
Using the GLOBE database

Materials and Tools

Pencil and graph paper, or computer tools
Computer and the GLOBE Student Server
GLOBE Science Notebooks

Preparation

Collect GLOBE data.

Prerequisites

None

Background

Although it sometimes takes many years to develop a data set to explore or answer questions about a site, GLOBE scientists have already begun to examine the growing set of GLOBE Hydrology data to get early indications of interesting trends and to monitor data quality. To help students begin to examine their own data and data from other schools, the GLOBE hydrologists want to share their preliminary investigations with you. Below you will find the early results from the analysis of pH and temperature data, as well as some interesting questions posed by examining other hydrology data. Since these investigations are ongoing, there will be updates as new data come in. These will be posted on the GLOBE Student Data Server at the Scientist's Corner. You can also find additional information on regional analyses on the WEB pages.

As more and more data become available in the archive, scientists will be continuing their efforts to look for interesting trends and to ask more questions. Students can assist in this effort by monitoring and analyzing the data over time from their own sites as well as from other sites around the globe and sharing their ideas and research with others in the GLOBE network.

What To Do and How To Do It

Section 1 of this activity contains a series of graphs that have been generated from GLOBE data on pH and temperature. These were chosen to illustrate particular questions commonly posed by

students or data quality problems commonly observed by scientists. Each set of graphs can be used as a starting point for further investigations or discussion of data analysis.

Begin by showing students the graph of 'typical' pH data and temperature readings. Discuss expected trends in data sets and encourage questions or comments on the data.

Then, with each of the following sets of graphs have students examine the data and pose hypotheses or ask questions about what they are observing. Record their observations. Once your students have examined the graphs and recorded their observations and hypotheses, compare their conclusions with what the scientists think may be happening. These recordings should be done in the students' GLOBE Science Notebooks. Students may then move on to the Further Investigations to analyze their own data or data from other sites.

In Section 2, GLOBE scientists have begun the initial examination of the newer GLOBE protocols: dissolved oxygen, alkalinity, and conductivity. Students can examine our graphs, then try to identify trends and problems with the new data measurements.

The graphs below can also be found on the WEB in the Scientist's Corner. Teachers may use these in print form, make overheads, or have students work at computer stations. In addition, more graphs and information on further research by GLOBE scientists are available on the WEB and can be downloaded for printing or used on the computer. Note: Copies of the graphs included in the activity are available in larger format in the *Appendix*. These can be used to make overheads for instruction or for duplication and distribution to students for analysis or assessment.

What is an example of a typical GLOBE data set?

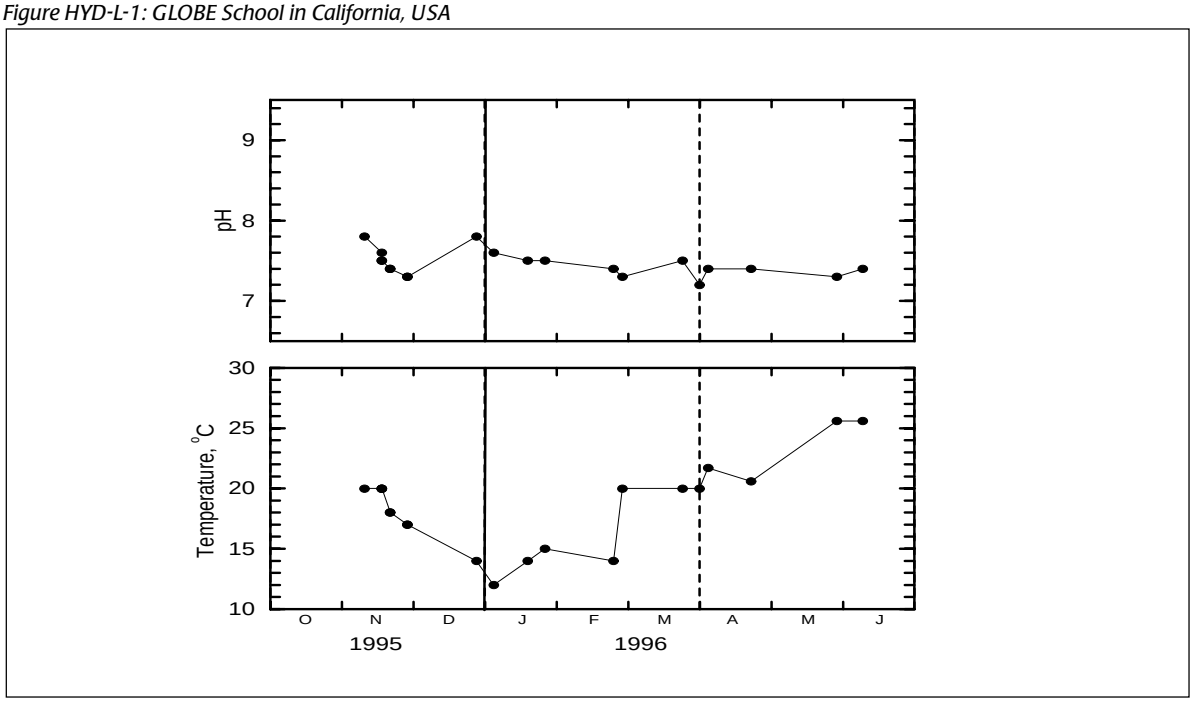
Typical characteristics

- pH data go up and down, but within a reasonable range.
- Temperature jumps around a little, but follows a seasonal trend.

Are there unusual things even in this data set?

Sure there are! Take a second look and think about the graphs in Figure HYD-L-1. Do you see anything surprising? Look at the jump up in pH from November to December! It could be a result of testing methods, but it might also be real! If

Figure HYD-L-1: GLOBE School in California, USA



equipment has been calibrated and multiple testing has shown the same result, these students should be trying to identify other factors which might cause an increase.

Section 1 - pH and Temperature Data

Part 1 - Identifying Outliers

1. Show students the graphs in Figures HYD-L-2 and HYD-L-3. After they have had an opportunity to examine the graphs and record their observations, ask them to identify any unusual data points.
2. Discuss the importance of data quality. Ask students what they should do if some data points are far beyond the range of the rest of the set (are they outliers)?
3. Discuss their observations and recommendations.

Note from the scientists

We have plotted all of the data as time series graphs. Before we can discern trends and compare data from different sites, we go through the data carefully looking for outliers. For example, notice in Figure HYD-L-2 that one temperature reading lies outside the range of the others. This is probably an error, and we will remove this point from our analysis before continuing.

In addition, pH readings that deviate significantly from the average are suspect. For Figure HYD-L-3, note the single pH 4 reading, with the rest of the pH's being in the 6-9.5 range.

Some additional items of interest can be seen looking at these graphs. Figure HYD-L-3 shows what appears to be a pH trend gradually climbing over the course of the record. The pH's seem to be more scattered than would be expected. Why do you suppose this is the case? In Figure HYD-L-2, we see a more typical variation in pH values, with a gradually increasing trend. This might be a problem associated with a buffer solution that was losing its accuracy, or it might actually represent a real pattern in nature!

Further Analysis

Encourage students to look at their own data. Time series graphs may be generated by importing GLOBE data into a spreadsheet, or by using the new GLOBE graphing tools to graph student data.

Figure HYD-L-2: GLOBE School in California, USA

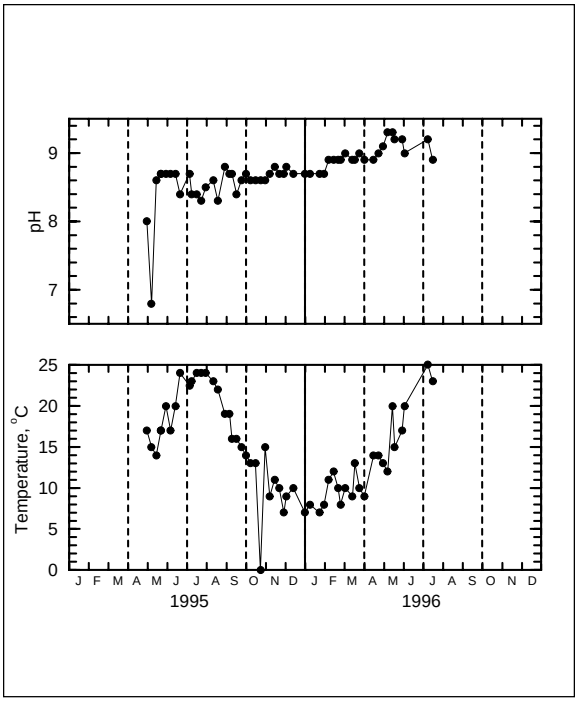


Figure HYD-L-3: GLOBE School in California, USA